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RESPONSE OF THINNED LODGEPOLE PINE AFTER FERTILIZATION

by

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Abstract

Significant increases in volume, basal area, and bole area growth continued during the second 4-year period after application of N, P, and S. Height growth, which was not increased significantly during the first 4-year period after treatment, was increased by the initial fertilization during the second 4-year period. Grass production in the understory continues to be higher on the fertilized plots.

KEYWORDS: Fertilizer response (forest tree), increment (volume), increment (height), lodgepole pine, *Pinus contorta*.

Metric Equivalents

1 pound/acre	= 1.121 kilograms/hectare
1 acre	= 0.405 hectare
1 foot	= 0.304 8 meter
1 inch	= 2.54 centimeters
1 square foot/acre	= 0.229 568 square meter/hectare
1 cubic foot/acre	= 0.069 972 cubic meter/hectare

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INTRODUCTION AND METHODS

Earlier, I reported[1] on a study to determine response of a pole-sized lodgepole pine stand to high application rates of fertilizer (600, 300, and 90 lb/acre[2] of N, P, and S respectively). The study, established in the fall of 1970 on the LaPine soil (a Typic Cryorthent), consisted of ten 1/10-acre plots in a 43-year-old stand thinned during 1966-1967. Five plots were randomly chosen for fertilization. Every tree on each plot was initially measured with an optical dendrometer and then remeasured at the ends of the fourth and eighth growing seasons (table 1).

Table 1--Some stand parameters for the study plots after eight growing seasons

Treatment and plot number	Basal area	Bole area[1]	Volume[1]	Average height	Average diameter[2]	Trees
	- - Sq ft/acre - -		Ft^3/acre	Feet	Inches	No./acre
Fertilized:						
9	30.8	3,833	474	30.8	7.3	100
7	43.9	6,970	864	42.8	7.8	130
10	48.8	7,231	936	42.2	8.2	130
5	69.7	11,068	1,341	42.8	7.8	210
1	68.2	11,014	1,504	49.8	8.8	160
Control:						
6	28.5	4,712	429	30.9	5.5	170
8	44.1	7,261	812	39.4	6.2	160
4	52.1	7,866	928	40.4	7.7	160
3	54.4	9,107	1,093	44	7.6	170
2	66.5	11,976	1,414	45.2	7.4	220

[1] Values are above a 1-ft stump.

[2] Actual average diameter , not diameter equivalent to the average basal area.

[1] Cochran, P. H. 1975. Response of pole-sized lodgepole pine to fertilization. USDA For. Serv. Res. Note PNW-247, 10 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

[2] Metric equivalents are on front cover.

During the first 4-year period, fertilization caused significant increases in annual volume, basal area and bole area growth, as well as grass production in the understory. Height growth did not respond to fertilization. This note reports response to the initial application of N, P, and S during the second 4-year period. Analysis of covariance (with basal area as the covariate) was used to determine if growth rates of volume, basal area, and bole area were increased by fertilization during the second 4-year period. Treatment effects on height growth and grass production were tested with t-tests.

RESULTS AND DISCUSSION

During the second 4-year period, growth of volume, basal area, bole area, and height were all significantly increased ($p \leq 0.05$) by the initial fertilization (table 2, figs. 1-3). Average annual height growth was 0.37 ft greater than for the non-fertilized trees (table 2) even though no significant difference in height growth occurred during the first 4-year period. Values for average annual growth of volume, basal area, and bole area equivalent to 40 sq ft/acre of basal area at the start of the growing

Table 2--Average annual growth for the second 4-year period after treatment

Treatment and plot number	Basal area	Bole area[1/]	Volume[1/]	Height
	--Sq ft/acre per year--		Ft^3/acre per year	Ft/tree per year
Fertilized:				
9	2.2	224.5	38.0	1.0
7	2.9	394	70.5	1.0
10	2.6	378.5	67.2	1.0
5	4.7	601.5	108.2	1.0
1	3.4	517.5	103.2	1.0
Average	3.2	423.2	77.4	1.0
Control:				
6	1.6	255.5	34.5	0.7
8	2.2	276.25	43.8	.6
4	2.0	268.5	41.5	.6
3	2.2	325.5	57.5	.6
2	2.0	386.0	69.5	.7
Average	2.0	302.4	49.4	.6

[1/] Values are above a 1-ft stump.

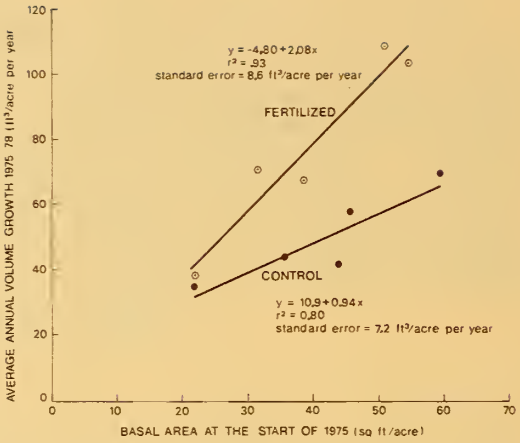

Figure 1.--Average annual volume growth during the 1975-78 growing seasons as a function of the basal area at the start of the 1975 growing season.

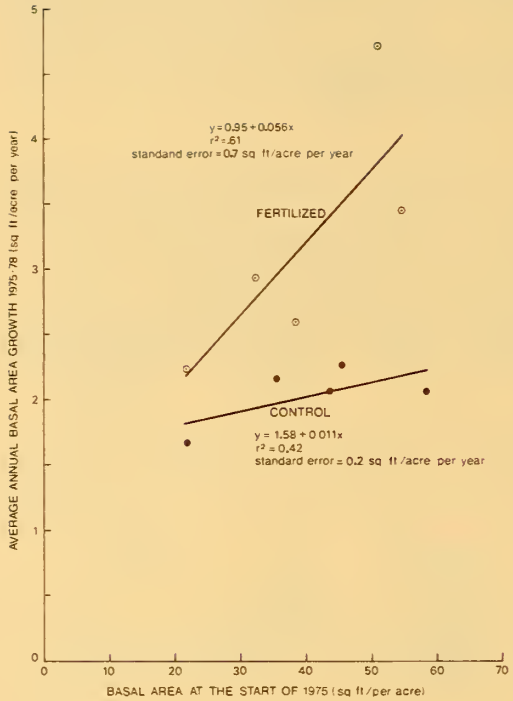

Figure 2.--Average annual basal area growth for the 1975-78 growing seasons as a function of basal area at the start of the 1975 growing season.

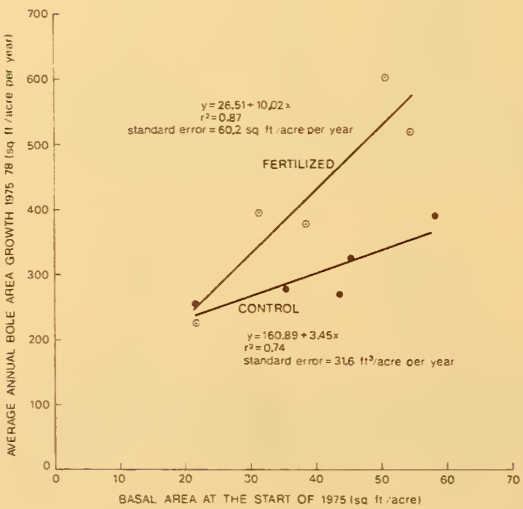

Figure 3.--Average annual bole area growth for the 1975-78 growing seasons as a function of basal area at the start of the 1975 growing season.

period were 62, 60, and 43 percent higher for the fertilized treatments than for controls (table 3). These percent increases due to fertilization are lower than the increases obtained during the first 4-year period (100, 100, and 77 percent) (see table 3).

Table 3--Comparison of average annual growth for each 4-year growing period[1/]

Growing period and type of growth	Average annual growth		Increase of fertilized treatments over controls
	Fertilized	Control	
			Percent
First growing period (1971-74):			
Volume[2/] (ft^3/acre per year)	73.8	36.8	100
Basal area (sq ft/acre per year)	3.2	1.6	100
Bole area[2/] (sq ft/acre per year)	432.5	244.7	77
Second growing period (1975-78):			
Volume[2/] (ft^3/acre per year)	78.4	48.5	62
Basal area (sq ft/acre per year)	3.2	2	60
Bole area[2/] (sq ft/acre per year)	427.3	298.9	43

[1/] Values represent growth produced by 40 sq ft of basal area per acre at the start of the growing period. The 40-sq-ft unit was used because it was within the range of initial basal areas for both growing periods and was close to the mean basal area for the 10 study plots at the start of the second period. Any other basal area within the range of the data could have been used with the appropriate regressions to calculate growth rates.

[2/] Values are above a 1-ft stump.

These reductions in percent increases of volume and bole area occurred during the second 4 years even though response of height growth to fertilization was delayed 4 years.

Production of grasses in the understory was monitored only for the 1978 growing season by clipping on four 2- by 12-ft transects randomly located on each plot. Grass production was increased ($p \leq 0.05$) by fertilization:

Treatment	Treatment averages dry weights (16 lb/acre)	Plot Ranges lb/acre
Fertilized	16.2	3.6-28.5
Control	4.2	0.7-6.6

Response of grass to fertilization also seems to be decreasing with time. In 1971 and 1974, treatment averages for fertilized plots were 37.8 and 68 lb/acre while treatment averages for non-fertilized plots were 7.4 and 3.7 lb/acre.

The application rates in this study are about three times as high as I would recommend for fertilization of thinned lodgepole or ponderosa pine stands on an operational basis. Further, the influence of S and particularly P seems minor in comparison to N for ponderosa pine on related soils.[3/]

Although fertilization continues to produce very large increases in yields, a questionable future still exists for fertilization of low-producing stands of lodgepole pine. Inquiries about fertilization continue to arise from land managers, however, and studies like this will be valuable in assessing the role of fertilization in fiber production for the future.

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3/ Cochran, P. H. 1979. Response of a pole-sized ponderosa pine stand to nitrogen, phosphorus and sulfur. USDA For. Serv. Res. Note PNW-319, 8 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

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